DOCUMENT RESUME

ED 160 395 SE 024 946

AUTHOR Childress, William R., Jr.; And Others
TITLE Domestic Rodent Control Training Manual: A Training Aid for the Rodent Control Category for Certification of Pesticide Applicators.
INSTITUTION District of Columbia Dept. of Environmental Services, Washington, D.C.; District of Columbia Univ., Washington, D.C. Cooperative Extension Services.
PUB DATE [75]
NOTE 71p.; For related documents, see SE 024 947-949; Not available in hard copy due to marginal legibility of original document

EDRS PRICE MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS *Agricultural Chemical Occupations; Guides; Health; *Manuals; *Pesticides; *Rats; *Rodenticides; Science Education

ABSTRACT

This training manual, designed for training applicants who wish to obtain certification in pesticide application relative to rodent control, covers the following topics: economic factors, public health factors, biological characteristics of domestic rodents, rat and mouse signs, trapping, repellents, poisons, baits, poisoned water, dumps, sewers, gassing, fumigation, dead rat odors, and ratproofing. (BB)

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DOMESTIC RODENT CONTROL

TRAINING MANUAL

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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GOVERNMENT OF THE DISTRICT OF COLUMBIA
DEPARTMENT OF ENVIRONMENTAL SERVICES
ENVIRONMENTAL HEALTH ADMINISTRATION
BUREAU OF COMMUNITY HYGIENE

Domestic Rodent Control Training Manual

A Training Aid for The Rodent Control
Category for Certification
of Pesticide Applicators

by

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Service of the District of Columbia

Foreword

This manual has been prepared under the general direction of Mr. James E. Murphy, Chief and Mr. William R. Childress, Deputy Chief of the Bureau of Community Hygiene, Environmental Health Administration, Department of Environmental Services, Government of the District of Columbia.

The main purpose of this manual is to aid in the training of applicants who wish to obtain certification in pesticide application relative to rodent control.

Note: The Department of Environmental Services does not endorse any of the mentioned products or manufacturing companies listed in this manual. The products and manufacturing agencies have been mentioned for identification purposes only.

This manual may be revised to reflect important changes in rodent control.

Preface

This training manual provides basic information that meets the standards of the Environmental Protection Agency for the certification of pesticide applicators. It prepares you for certification in category B and subcategory 5, administered by the Department of Environmental Services, Government of the District of Columbia.

The manual will not furnish you with all knowledge of industrial, institutional, structural and health-related pest control. Additional information can be obtained from the Plant Pathology and Entomology Division, Cooperative Extension Service of the District of Columbia. Address your question or request to D.C. Cooperative Extension Service, 1351 Nicholson Street, N.W., Washington, D.C. 20011. Lectures, short courses, publications, demonstrations and other educational materials will supplement this manual.

Table of Contents

	Page
Introduction	1
Economic Factors	2
Public Health Factors	2
Key To Rodents	5
Biological Characteristics of Domestic Rodents	16
The Senses and Reactions of the Commensal Rodents	19
Factors to Consider on Domestic Rodents	22
Rat and Mouse Signs	24
The Control of Rodent Populations	28
Sanitation	31
Trapping	35
Repellents	38
Poisons and Their Mode of Action	39
Suggested Formulations	42
Anticoagulant Baits	42
Single Dose Poisons	44
Preparation of Baits	46
Bait Placement	48
Poisoned Water	49
Prebaiting	49
Poisoning at Dumps	52
Poisoning In Sewers	52
Gassing	53
Fumigation	55
Other Killing Methods	56
Related Problems	56
Dead Rat Odors	58
Carcass Disposal	58
Ratproofing	59
Information and Education	62
Summary	64
References	65

DOMESTIC RODENT CONTROL TRAINING MANUAL

INTRODUCTION

About one-third of all mammals are classified as rodents. This classification contains animals such as squirrels, gophers, woodchucks, field and wood mice, pack rats, beavers, prairie dogs, lemmings, muskrats, porcupines, etc. They vary considerably in their habitat from tree-dwellers that are capable of gliding flight, semi-aquatic dwellers that live in fresh or swamp water, arid dwellers with swift bounding movements to terrestrial burrowing cliff dwellers.

Rodents are animals that vary in size from the tiny Pigmy Mouse (weighing only a fraction an ounce) to the huge Capybaras of South America that weigh over 120 pounds.

The species of rodents that we are mostly concerned with in rodent control are the Old World rats and mice. These species belong in the Muridae family. Sometimes they may referred as domestic rodents and also Commensal rodents. Included in the family Muridae are the Norway Rat (Rattus norvegicus), the Roof Rat (Rattus rattus) and the House Mouse (Mus musculus). Evidence indicates that all three of the above mentioned rodents are native to Asia and have spread throughout the world from there.

In the United States the Norway Rat may be found along with the House Mouse, everywhere. The Roof Rat on the other hand is confined to warmer climates and reaching up as far North as Norfolk, Virginia and from there down the Atlantic coast, the coast of the Gulf of Mexico and Pacific Ocean.

ECONOMIC FACTORS

There is a tremendous quantity of food, feed and other properties destroyed yearly by rats. It is estimated that rats cost the United States over $1,000,000,000 anually. This includes destruction and contamination of food products, destruction of wordly goods and the destruction by fire caused by rats gnawing electric wires.

PUBLIC HEALTH FACTORS

Rodents are a constant threat to the health of human beings. These rats and mice can cause diseases in man by directly infecting food supplies through their urine and feces. Indirectly they can also cause diseases through infected rat fleas and mites. Another method of disease transmission is through the rat bites. The most important rat borne diseases are discussed below:

RAT-BITE FEVER

Many rats carry two types of disease organisms in their gums and teeth that cause Rat-Bite Fever. In the United States the bacteria called Streptobacillus moniliformis causes Rat-Bite Fever commonly known as Haverhill Fever. Another bacteria know as Spirillum minus causes Rat-Bite Fever in the Orient where the Japanese term, sodoku (literally it means rat poison) is applied to Rat-Bite Fever.

LEPTOSPIROSIS

This disease is also known as Weil's Disease and the causative organism is Leptospira icterohemorrhagiae. This condition is seldom fatal and ranges from a mild to severe infection. There have been outbreaks of this disease in

swimmers exposed to water that is contaminated by urine of domestic or wild animals. Weil's disease is prevalent in rice field workers, sugarcane field workers, farmers, sewer workers, miners, veterinarians, animal farmers, abattoir workers, fish workers and military troops.

SALMONELLOSIS

Food infection or gastroenteritis is a disease of world-wide distribution. Organisms or bacteria from the Salmonella group can cause large disease outbreaks in hospitals, institutions for children, restaurants, nursing homes, and these outbreaks are due to food contamination at its source or cross-contamination during food preparation or possibly from a human carrier. Food may be contaminated by infected feces of rats and later this food is ingested by its human victims.

TRICHINOSIS

Trichinosis is caused by the ingestion of infected pork or other meats that are not properly cooked. Hogs get infected by eating trichina-infected feces of rats and mice. This disease is world-wide, but the incidence depends on the practices of eating and preparing pork. The larva and cysts of the intestinal roundworm Trichinella spiralis is the causative agent. Other names for the disease are Trichiniasis and Trichinellosis.

MURINE TYPHUS FEVER

Murine Typhus Fever (Endemic Flea-borne) resembles epidemic louse-borne typhus, but seems to be milder. As one of the

names implies, the causative agent, Rickettsia typhi (Rickettsia mooseri) is transmitted from rats to man by the rat flea, Xenopsylla cheopis for the most part. After an infected rat flea bites a human, it defecates on the skin and the causative organism enters the body through the site of the bite or abraded skin when it is scratched.

PLAGUE

Plague is a highly infectious disease. It occurs in three clinical forms. The most common is the Bubonic plague and the other two forms are Primary septicemic plague and Primary pneumonic plague and this last type is the most serious form.

The causative agent of this disease is the plague bacillus, Pasteurella pestis. The disease is transmitted by the bite of an infected rat flea, Xenopsylla cheopis (this is the same flea that transmits Murine Typhus Fever) whose throat is blocked by the accumulation of the bacillus and is forced to regurgitate these organisms directly into the bite site and into the blood system of the victim. The disease killed millions of people in Europe, Asia, and Africa and was commonly known as the "Black Death." The disease presently exists in wild rodents and there is a constant threat that domestic rodents may become infected and start epidemics again.

RICKETTSIAL POX

The mite of the infected House Mouse is the vector for Rickettsial Pox. The scientific name of the mite is Allodermanyssus sanguineus and the causative agent of the disease is Rickettsia akari.

OTHER DISEASES

Other diseases are the following: Toxoplasmosis (causative agent is Toxoplasma gondii), Listeriosis (causative agent is Listeria monocytogenes) and Lymphocytic choriomeningitis caused by a virus.

KEY TO RODENTS

The following key may be used to compare the various characteristics of rodents and how they differ from one another. This is not a complete key, but it includes the better known rodents.

Key to Rodents

1. Hind leg not two times longer than front legs; external fur-lined cheek pouches present 2
   Hind legs two or more times longer than front legs; external fur-lined cheek pouches present 25
2. Tail (bones) longer than one-half body and head length 3
   Tail (bones) length equal to or less than one-half that of the head and body 15
3. Tail almost naked, with fine scales and hairs 4
   Tail not scaled, not naked (although short hairs on some species make them appear so). 5
4. Adults less than 7 inches long from head to tip of tail
   (Genus Mus) See Figure 1 . . . . . House Mouse

Figure 1.

Mus musculus (House Mouse)

Adults more than 15 inches long

(Genus Rattus) See Figures 2 and 3 . . . Norway and Roof Rats

NOTE: All drawings of rodents above and below are not in proportion to actual size or in proportion to each other. Some may appear larger than others, but this is incidental.

Figure 2.

Rattus norvegicus (The Norway Rat)

Figure 3.

Rattus rattus (The Roof Rat)

5. Tail with more or less distinct rings 6

   Tail without definite rings . . . . . .

6. Head short and thick, no neck; fur coarser; tail usually dark above and beneath (Genus Sigmodon) See Figure 4 . . . . . Cotton Rat

Figure 4.

Sigmodon hispidus (Cotton Rat)

Head long and slender, neck evident; fur finer; tail usually dark above, pale beneath (Genus Oryzomys) See Figure 5 . . . . . Rice Rat

Figure 5.

Oryzomys palustris

(Rice Rat)

7. Tail round in cross-section 8

Tail flattened from side to side; feet partially webbed (Genus Ondatra) See Figure 6 . . . . . Muskrat

Figure 6.

Ondatra zibethicus (Muskrat, Musquash)

8. Half of tail nearest body slender and round, not bushy 9

Entire tail bushy or fluffy 11

9. Whiskers reach to or beyond base of front leg

(Genus Neotoma) See Figure 7 . . . . . Wood Rat

Figure 7.

Neotoma albigula

(White-throated Wood Rat)

Whiskers do not reach to base of front leg 10

10. Tail same color above and beneath

(Genus Reithrodontomys) See Figure 8 . . . . . Harvest Mouse

Figure 8.

Reithrodontomys megalotis (Western Harvest Mouse)

Tail bicolored, dark and light below

(Genus Peromyscus) See figure 9 . . . . . Dear Mouse

Figure 9.

Peromyscus californicus

(California Deermouse)

11. Whiskers reach to base of front leg 12

    Whiskers do not reach to base of front let 14

12. Tail as long as head and body

    (Genus Sciurus) See Figure 10 . . . . . **Tree Squirrel**

Figure 10.

Sciurus niger (Eastern Fox Squirrel)

    Tail shorter than head and body 13

13. Membrane present between front and hind legs

    (Genus Glaucomys) See Figure 11 . . . . . **Flying Squirrel**

Figure 11.

Glaucomys volans (Southern Flying Squirrel)

Membrane absent between front and hind legs

(Genus Neotoma See Figure 7 . . . . . Wood Rat

14. Strips on cheeks

(Genera Tamias and Eutamias) See Figures 12 and 13 . . . Chipmunk

Figure 12.

Tamias striatus (Eastern Chipmunk)

Figure 13.

Eutamias minmus (Least Chipmunk)
Western example

No strips on cheeks

(Genus Citellus) See Figure 14 . . . . . Ground Squirrel

Figure 14.

Citellus franklinii

(Franklin' Ground Squirrel)

15. Tail round; feet not webbed 16

Tail flattened from top to bottom; feet webbed

(Genus Castor) See figure 15 . . . . . Beaver

Figure 15.

Castor canadensis (Beaver)

16. Tail slender and pointed with fine hairs 17

Tail hairy, not slender and pointed, with a fluffy or brush-like arrangement of hair 22

17. Claws on front feet longer than on hind feet 18

Claws on front and back feet about equal length 19

18. Upper front teeth grooved. Found in Eastern U. S.

(Genus Geomys) See Figure 16 . . . . . Eastern Pocket Gopher

Figure 16.

Geomys bursarius (Plains Pocket Gopher)
Eastern Pocket Gopher

Upper front teeth without grooves. Found in Western U. S.

(Genus Thomomys) See figure 17 . . . . Western Pocket Gopher

Figure 17.

Thomomys bottae (Valley Pocket Gopher)
Western Pocket Gopher

19. Tail with white tip

(Genus Onychomys) See figure 18 . . . . . Grasshopper Mouse

Figure 18.

Onychomys leucogaster (Northern Grasshopper Mouse)

Tail without white tip 20

20. Fur reddish on back contrasting with pale gray on sides

(Genus Clethrionomys) See figure 19 . . . . . Redback Vole

Figure 19.

Clethrionomys gapperi

(Northern Red-Backed Vole, Mouse)

Fur brownish on back and sides 21

21. Fur grizzled, tail over one inch long

(Genus Microtus) See figure 20 . . . . . Field Vole or Meadow Mouse

Figure 20.

Microtus pennsylvanicus (Meadow Vole, Meadow Mouse)
Field Vole

Fur not grizzled, but thick and short, tail one inch or less

(Genus Pitymys) See figure 21 . . . . . Pine Vole

Figure 21.

Pitymys pinetorum (Pine Vole, Pine Mouse)

22. Crown of head dark or black with or without a few hairs

(Genus Marmota) See figure 22 Marmot and Woodchuck

Figure 22.

Marmota caligata (Hoary Marmot)

Crown of head same color as back 23

23. Feet dark brown or black

(Genus Marmota) See figure 23 . . . . . Woodchuck

Figure 23.

Marmota monax (Woodchuck,'Ground Hog')

Feet same color as body fur 24

24. Back tan or light brown color, hair lies close to body like that of a short-haired dog (Genus Cynomys) See Figure 24 . . . . Prairie Dog

Figure 24.

Cynomys leucurus (White-tailed Prairie Dog)

Back dark brown or gray, hair soft like fur (Genus Citellus See figure 14 . . . . . Ground Squirrel

25. Tail has definite brush of hair on tip 26

Tail without definite brush of hair at top (Genera Zapus and Napeozapus) See figures 25 and 26. . . Jumping Mouse

Figure 25.

Zapus hudsonius

(Northern Jumping Mouse) Kangaroo Mice

Figure 26.

Napaeozapus insignis

(Woodland Jumping Mouse) Kangaroo Mouse

26. White markings on head (Genus Dipodomys) See figure 27 . . . . . Kangaroo Rat

Figure 27.

Dipodomys spectabilis

(Banner-tailed Kangaroo Rat)

No white markings on head

(Genus Perognathus) See figure 28 . . . . . Pocket Mouse

Figure 28.

Perognathus formosus

(Long-tailed Pocket Mouse)

BIOLOGICAL CHARACTERISTICS OF DOMESTIC RODENTS

A comparison between the Roof Rat, Norway Rat and the House Mouse is shown in Figure A. It can observed that the Roof Rat is much slender than the Norway Rat. However, a young Roof Rat can be distinguished from a House Mouse by having larger head and feet.

The Norway Rat

The Norway Rat (Rattus norvegicus) is the largest domestic rat and is also known as the Brown Rat, the House Rat, the Sewer Rat, the Wharf Rat and the Barn Rat.

Adult Weight: 16 or more ounces; average about a pound

Fur: Coarse, reddish brown to grayish brown, with many variations

Body: Heavy-set, blount nozzle

Tail: Bicolored, shorter than body and head combined

Ears: Small, close-set

Droppings: Large (one-half to three-quarters of an inch long), capsule shaped-blunt

Sexual Maturity: In two to three months

Gestation Period: About 22 days

Young: Average 8 to 12 per litter

Number of Litters: Average 4 to 7 per year

Number Weaned: About 20 young per year per female

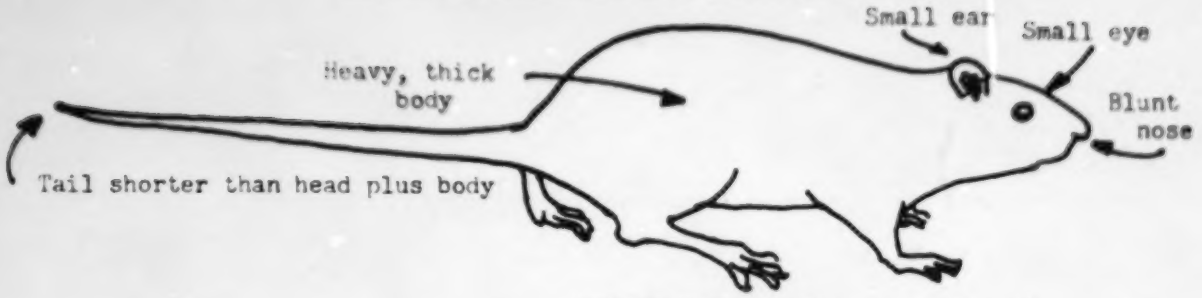
Length of Life: Average about 1 year

Harborage: Outdoors- in burrows in the ground and under foundations of buildings, in rubbish dumps; indoors- between floors, between walls, in enclosed spaces of cabinets, shelving and appliances, in piles of rubbish and in any other space concealed from view.

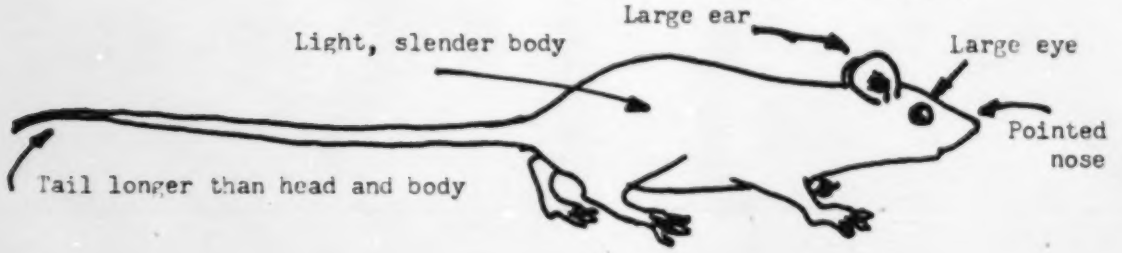
Range: Frequently 100-150 feet

Figure A.

COMPARATIVE SCALES OF DOMESTIC RODENTS



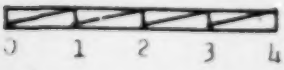
NORWAY RAT (Rattus norvegicus)



ROOF RAT (Rattus rattus)

YOUNG RAT

HOUSE MOUSE (Mus musculus)



Food and Water: Omnivorous; garbage, meat, fish and cereal baits are well accepted; daily reqirements- three-quarters to one ounce of dry food, one-half to one ounce of water.

The Roof Rat

The Roof Rat is rarely to be found in cold environments. It mostly inhabits the tropical or temperate regions. In the U. S. it is found in the Southern part, the Pacific Coast and in Hawaii. This rat is smaller than the Norway Rat.

Adult Weight: 8 to 12 ounces

Fur: In the U. S. there are three color phases: the Black Rat (Rattus rattus rattus), black to slate colored; the Alexandrine Rat (Rattus rattus alexandrinus), tawny above and grayish-white below; the Fruit Rat (Rattus rattus frugivorus), also tawny above with white to lemon colored belly. These three subspecies interbreed and they have prominent guard hairs.

Body: Slender, muzzle pointed

Tail: Single color, longer than body andhead combined

Ears: Large, prominent

Droppings: Medium sized (one -third to one-half inches long) spindle shaped, see figure

Sexual Maturity: Attained in two to three months

Gestation Period: About 22 days

Young: Average 6 to 8 per litter

Number of Litter: 4 to 6 per year

Number Weaned: About 20 young per female

Length of Life: About one year

Harborage: Above ground level; indoors- in attics, between walls and in enclosed spaces of cabinets and shelving; outdoors- in trees and dense vine growth, and in some California cities, in sewers

Range: 100-150 feet

Food and Water: Omnivorous, vegetables, fruits and cereal grains preferred; daily requirements is one-half to one ounce of dry food and up to one ounce of water

The House Mouse

This small rodent is found throughout the world in either hot or cold climates. It is the smallest of the domestic rodents. In the United States it occurs everywhere.

Adult Weight: One-half to three-quarters of an ounce

Fur: Dusky-gray

Body: Small, slender

Tail: Semi-naked, about as long as head and body combined

Ears: Moderately large, prominent

Droppings: Small (three-sixteenths inch long), rod-shaped, see figure

Sexual Maturity: Attained in one and one-half months

Gestation Period: Average 19 days

Young: 5 to 6 per litter

Number of Litters: As many as 8 per year

Number Weaned: Average 30 to 35 young per year per female

Length of Life: About one year

Harborage: Any convenient space in walls, cabinets, furniture or stored goods

Range: Frequently 10 to 30 feet

Food and Water: Omnivorous; cereal grains, the mouse is a nibbler; daily requirements is one-tenth of an ounce of dry food, requires little water (three-one hundres of an ounce) often obtained in the food it eats

THE SENSES AND REACTIONS OF THE COMMENSAL RODENTS

Touch

Rats and mice like to run next or between walls so that they can keep their highly developed tactile hairs (called guard hairs) and sensitive whiskers or vibrissae in contact with these surfaces-thus the rub marks on the walls.

Vision

These animals apparently are color blind and their vision is not too well developed so poison baits are accepted just as well regardless of coloration.

Smell

What these rodents lack in eyesight they make up by having a very keen smell. However, they will eat rat baits that have been handled by man as they are accustomed to the smell of man.

Taste

Rats prefer to eat fresh food rather than decayed food. Their taste is not as sensitive as that of man. If poison bait makes them sick, they soon become "bait shy" to the particular mixture not to the poison.

Hearing

Rats have a very keen sense of hearing and can locate the source of a sound within a half foot. A loud noise will cause them to disperse in a hurry. Sound is of great importance to them as their activities, to a great extent, are carried out in darkness.

Balance

Rats, like cats, have an excellent equilibrium and this is evidenced when they both land on their feet when they fall. The Roof Rats can walk on suspended wires by using their tails for balance.

Reactions to Strange Objects

Rats seem to be very suspicious by nature and probably is one of the reasons they have survived through the ages. They will avoid new objects for two or three days until they have become accustomed

to them. These new strange objects may include food, garbage, etc. In high populations of rats they may show "chain-fright reaction" to any disturbance. Mice show a different attitude to new objects; and in fact they are continually exploring and as a result they are easily caught in traps.

Climbing

The Roof Rat is a very resourceful climber and usually prefers to live in the upper structures of human habitations. The Norway Rat is a heavier animal and likes to burrow under trash, under buildings and embankments with heavy grass cover. The House Mouse is also a good climber. The Norway Rat if required can also prove to be a fair climber.

Jumping and Reaching

By using their tails for support rats can reach up to 18 inches. Their jumping abilities are weil developed as they can jump vertically 2 feet high and with a running jump they can increase that height to 3 feet. Horizontally they can jump 4 feet and 8 feet from an elevation that is 15 feet above the finish point.

Swiming

The rodents mentioned above are all good swimmers and of these three the rats are by far superior in this category. They are known to swim a half mile in open water. Even young rats prove to be good swimmers when introduced into a container of water. They will even dive repeatedly to the bottom of the container looking for an avenue of escape. Reports show that rats may swim up drains through the access of broken sewer pipes.

FACTORS TO CONSIDER ON DOMESTIC RODENTS

A. Birth and Development

Much of our knowledge about the biology of rats comes from extensive research done with the laboratory rat, Rattus norvegicus. Much more information is needed, however, about some of the less well known forms of rats in other parts of the world. In general, Norway rats build their nests in burrows at ground level, whereas roof rats make nests in trees, dense vegetation or attics of buildings. Born in a nest about 21 to 23 days after mating, the young rats are naked and their eyes are closed. Females may mate again within a day or so of littering. When this occurs, the gestation period may be a few days longer than otherwise. The young develop rapidly, growing hair within a week; and when they are 9 to 14 days old their eyes open and they begin to explore for food and move about near their nest. In the third week they begin to take solid food. The size and number of litters depend on the species of rat and vary with nearness to the limit of their climatic range, availability of nutritious food, density of thelocal rat population, and age of the rat. In general, Norway rats and roof rats have large litters (6-12) whereas the Polynesian rat is more likely to have only (3-6) young.

The young may continue to nurse until four or five weeks old; by this time they have learned a good deal about what is good to eat by experimenting with potential food items and by imitating their mother. If a mother rat has become shy to a specific kind of bait or rodenticide, which is called bait shyness, many of her young will quite likely learn to avoid eating it if exposed to the bait while exploring with their mother. When about one month old Norway rats weigh about 1 1/2 oz (45 grams). At about three

months of age they are completely independent of the mother and are reproductively mature. The females come into heat every four or five days and remain receptive to males for a day or two. Breeding seasons vary in different areas. In tropical or semi-tropical regions the season may be all year, but the litter size may be smaller. In much of the temperate regions there may be peaks in breeding in the spring and fall. There is a lessening of breeding in the hot summer and nearly a complete cessation in winter, depending on the habitat.

B. Feeding Behavior

Most kinds of rats are quite omnivorous, eating nearly any type of food, although each kind and population has its own preferences. The Norway rat is an avid consumer of man's garbage, whereas the roof rat and Polynesian rat generally prefer more natural plant food if available. They all feed to varying degrees on garbage, meat, fish, cereal grains, nuts, fruits, vegetables, invertebrates, and even manure, dog feces, depending on the habitat conditions.

Rats usually begin searching for food shortly after sunset. When hungry or under crowded conditions, they may also be seen in daylight. If the food is in an exposed area and too large to be eaten quickly, yet not too large to be moved, they will usually carry or drag it to a hiding place before eating it. Many rats will hoard considerable amounts of solid food, which they may or may not eat later. The water requirement varies with species and diet, but most rats drink water regularly if it is available. Norway and roof rats usually require water daily, though their local diet may provide an adequate amount. Totally different types of food may be highly preferred, particularly if they fulfill a dietary need for the particular rat population.

RAT AND MOUSE SIGNS

Droppings

Fresh feces are moist, shiny, soft and dark and become hard and dry after a few days and soon with age they will acquire a dull grayish color and will crumble when touched with a stick. See figure 29.

Figure 29

Norway Rat

1/2 - 3/4 inches long
1/4 in. thick

Blunt edges

Roof Rat

1/3 - 1/2 inches long
3/16 in. thick

Pointed edges

House Mouse

3/16 - 1/2 inches long

Without ridges

American Cockroach

1/8 inch long

With ridges

The presence of rodent droppings is an indication that the animals are close by

Runways

Well worn clean swept, well-packed paths 2 to 3 inches wide by the Norway Rat may be found outside from their burrows to the food supply. The runways inside of buildings will found next to walls since these rats prefer to have their bodies in constant contact with walls by using their vibrissae (whiskers) and other specialized hairs. These indoor runways are greasy looking and may also be found along steps and rafters. Cobwebs over these paths and an accumulation of undisturbed dust will indicate that said runways are not in use.

Rubmarks

Norway rats usually will leave rubmarks close to the floor. Roof rats will usually leave rubmarks along beams above. Mice rubmarks may be anywhere. These latter marks are smaller, fainter and hard to see. For the most part these rubmarks are dark and greasy and will smear when rubbed if they are freshly made. The older rubmarks will gather dust and can be flaked off when scratched with your fingernail.

Tracks

Tracking powder or just plain accumulation of dust may show the presence of rats. Usually the hind feet (five-toed) will be seen more often than the front paws (four-toed). Often you may observe the tail marks between the feet marks. A flashlight should be used to find these tracks. Insecticidal dusts may be used as tracking powder and it may serve to eliminate the rats' ectoparasites. Other materials that can be used are talcum powder, flour, etc.

Gnawing

Fresh gnawings can be identified by the light colored appearance of the gnawed area. The edges of the gnawed area darkens within a few

days. The edges, when new, are sharp and in contrast with the older gnawed edges which are dull. This dullness of the older gnawed edges is caused by the constant rubbing of rats' bodies and also further gnawing by the rats to eliminate the sharpness of said edges. The extent of the gnawing indicates the amount of rat infestation. Care must be exercised in determining whether one or more species of rodents are present.

Burrows

Burrows caused by Norway Rats may be found under buildings, in dirt basements, under trash, in embankments, hedge rows and in heavy growth of bushes. Roof rats may dig burrows, but this is not a common occurence.

Mice that live out may burrow, but these holes are about an inch in diameter and in contrast with the burrows made by the Norway Rat which are about 3 inches in diameter. Old unused burrows will be dusty and may be covered with cobwebs. New burrows will have a slick beaten-down appearance. These burrows may be shallow and complex where several holes may lead to the same system. Before burrow gassing is attempted, a study must be made of the area to find all the holes.

Nests

Usually, rodents will build nests near the food and water supply. Safety is another factor taken in consideration in building nests. Burrows may be used for hiding or for nesting when outdoors. Indoors, nesting places may be found between double walls, spaces under flooring and in ceiling, around counters, under furniture or equipment when closed-in or any other space that is not disturged and is hidden from view. Rubbish, trash that is left unmolested may afford harborage and

nesting places.

Mice colonies have been found living in cold storage warehouses where temperatures are kept below 15°F and the mice lived on the meat stored. Nesting material was gathered from bird feathers and rabbit furs.

Roof Rats may build large closed nests in trees similar to the nests of squirrels. The materials with which rats and mice construct their nests with are usually soft of texture and found nearby. Paper, grasses, twigs, etc. may be torn up and used to line their nests. Rats nests are about eight inches in diameter and usually bowl-shaped and may be roofed over. The nests of mice are very similar to those of rats, but are about five inches in diameter and usually are completely covered leaving a very small hole for entrance.

Feeding Stations

While checking out for rat and mice nesting sites you will probably encounter feeding stations. Feeding stations are usually quite out of the way places between the nesting spot and the food supply. The rodents will feed here undisturbed and will also defecate in the same spot and in addition leave behind bits of food, food wrapping, etc. These runways are usually concealed.

THE CONTROL OF RODENT POPULATIONS

Controlling rat populations, not individual rats, is the key to a successful rodent-control program.

At any moment a given geographical area has a certain capacity to support rats. This capacity relates to the availability of palatable food, harborage, living space, and the availability of all necessary breeding conditions. The rat population in a given area cannot be greater than this capacity. Rat killing activities can temporarily reduce the size of the population, but as long as the capacity of the environment does not change, the rodent population will remain at essentially the same level. To change the level of a rodent population, it is necessary to change the capacity of the environment to support rodents.

There are three population forces that determine the size of a rodent population at any given time. These are: 1. reproduction, 2. mortality and 3. movements. Reproduction will tend to increase the population; mortality will tend to make it smaller: and movements may work in either direction. The relative balance of these population forces determines whether a population is growing, shrinking, or staying the same.

The reproduction of rats and mice takes place throughout the year, but this breeding follows three main patterns: a. two breeding peaks (Spring and Fall); b. one breeding peak (Spring); c. no definite peak. The pattern of two peaks is more common.

This knowledge of rodent breeding seasons may help the control programs since the best time to strike at the population is when breeding is at a minimum. In general, a rat killing campaign would be most successful if carried out in the winter. The next best choice would be summer, and the next, fall. In field tests, populations poisoned in the winter took 12 months to return to normal; those poisoned in the summer, only

six months.

As rat and mouse populations increase in size the mortality rate also increases until a state of equilibrium is reached. Increased competition due to population pressure increases the mortality and movements of rodents. Movements into or out of an area are less important in determining the size of rat populations than either reproduction or mortality.

The factors that control the balance between reproduction, mortality, and movements of rodents are: the physical environment, predation and parasitism, and competition.

The physical environment is comprised of three main elements: 1. food and water, 2. harborage, and 3. climate. Improperly handled foods, garbage, and field crops often are major sources of rodent food. Climate directly affects the number of rodents able to survive outdoors, but has little or no effect on those living in heated buildings. Generally speaking, areas with warm moist climates are favorable, while those with dry cold climates are unfavorable. Man can reduce rodent populations and keep them low by permanently eliminating their food, water, and harborage.

Competition whether between members of the same species or between two or more species is one of the most important factors limiting rat populations. Norway rats compete intensely with Roof rats and have replaced them over large areas, particularly in many cities where both once were found. Competition among members of the same species is very closely associated with the social organization of a population. A definite social order or hierarchy exists among rats and mice. This social order is determined largely by fighting, and the most aggressive animals in a population are dominants. Others are killed or are forced to move. Those that move may suffer even higher mortality from predators and resident rodents in the new areas. The strife caused by increased population pressure lowers

reproduction, increases mortality, and decreases the population.

The effect of predators and parasites on reduction of rodent populations appears to be temporary. This includes the predatory activities of man, dogs, cats, foxes, rats, birds, snakes and other foes, and the parasitic activities of bacteria, rickettsia, spirochetes, protozoa, and worms.

In summary, the most lasting control can be achieved by increasing competition and predation through permanent alterations of the physical environment. Environmental sanitation is the first and foremost requirement for rodent control.

Sanitation

Proper control of solid waste is the key to upgrading environmental quality and thus remove blight. The overall attitude of citizens and public officials toward the residues of resource utilization might be that any material becomes a waste when its owner or producer no longer considers it of importance to be an asset. Once the residue of resource utilization is no longer valued by the owner, he divests himself from investing any money in it as it would be financially unrewarding. However, this same individual may deplore unsightly debris or rodents or other conditions which result from his loss of interest in ownership. This attitude, whether practised at home or at any business establishment could lead to rat infestation in blocks and neighborhoods.

Refuse Storage

1) Community Refuse Storage

Good refuse storage techniques should be practised mainly for health and sanitation reasons so as to prevent: (a) vectors (b) odors, and (c) unsightliness. It also helps in expediting collection. Although the responsibility for refuse storage is an individual one, the government also shares guidelines through recommendations and ordinances and the enforcement of the ordinances.

2) Residential Refuse Storage

The containers should be of manageable size (20-30 gallon capacity) and convenient shape (tapered for easy emptying). The material from which the container is made must be durable and easily cleaned. The contents should always be protected from scattering and should exclude vectors. In addition the

containers should have tight fitting lids and handholds.

To further increase the durability of the containers, the following procedures should be adopted:

1) Wrap refuse.

2) Use storage racks.

3) Wash containers.

The area surrounding the containers should be free from litter, vectors and materials not intended for disposal.

The attitude of the homeowner, the socio-economic level and local customs are factors that affect refuse storage.

3) Commercial and Industrial Refuse Storage

They share responsibility with individuals and government for good refuse storage. The nature and quantity of the refuse generated may be of special character, therefore the containers should be of the shape, volume and construction to meet the particular needs of the nature and volume of waste generated. See Figures a, b and c.

Point of Collection

Probably, the level of collection service most apparent to the average resident is the point of collection, that is, where the waste is picked up. Approximately 60% of the collection systems in the United States are curbside and alley; 40% are backyard.

Any efficient collection service improves refuse storage practices thus preventing the overloading of individual storage facilities which provide exposed food for rats and a breeding medium for flies.

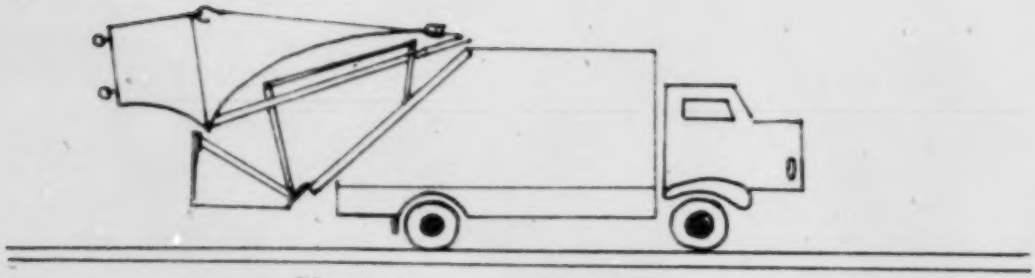


Figure a.

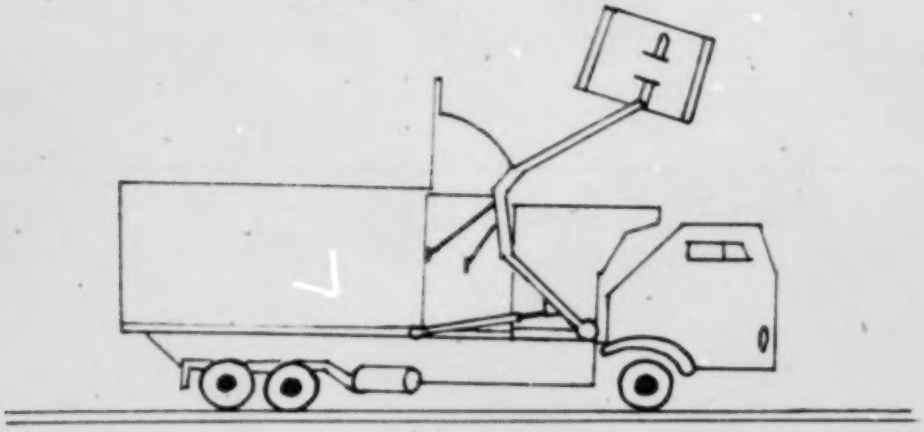


Figure b.

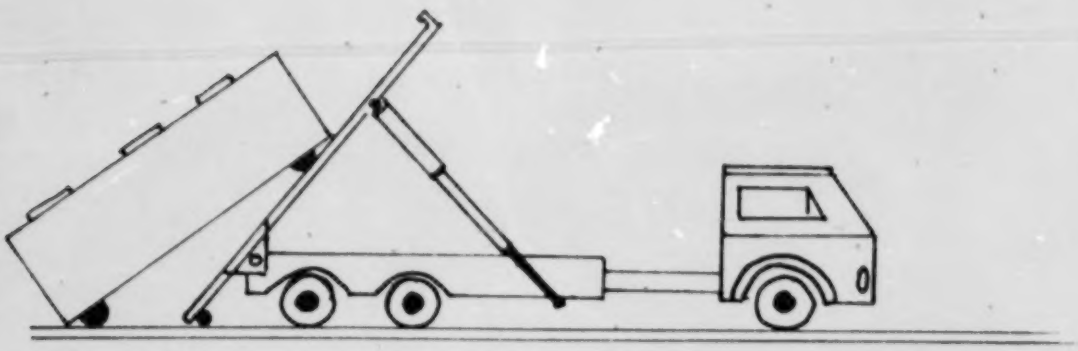


Figure c.

For health reasons, the minimum acceptable frequency of collection for residential waste containing food waste and other putrescible material is once a week. On the other hand, in the inner city neighborhoods, the inadequacy of the storage facilities for the amount of waste generated makes frequent collection necessary.

The compactor type trucks are the equipment of choice for collection because of the following:

1) prevent contents from blowing or spilling out.
2) leakproof.
3) easy to load and unload.

Trapping

Trapping of rats and mice is just as effective as poisoning them, however, trapping requires more skill and labor. Trapping is recommended where the use of poisons is inadvisable. Careful attention to detail is necessary in any trapping procedures, as this will dictate the success or failure of the activity. Skill and resourcefulness are an integral part of the trapping procedure.

Woodbase Snap Traps

Although the more complicated traps and devices for catching rats and mice are sometimes useful, the simple and inexpensive traps have proven to be the most effective and consistent rat and mouse catchers. See figures 30A and 30B.

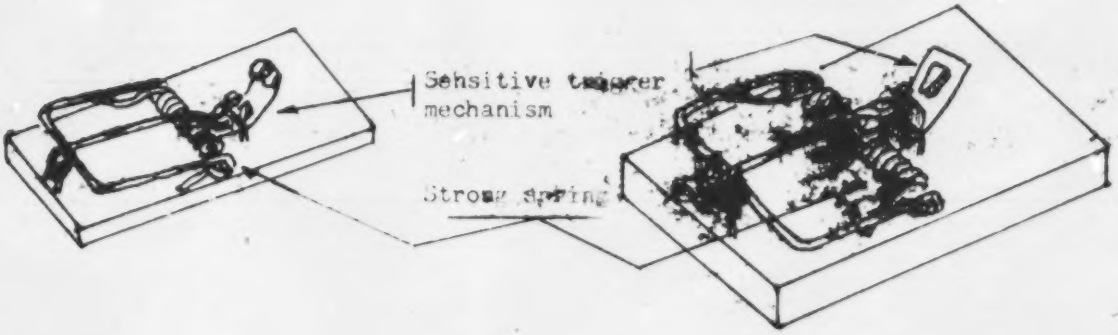
Mouse Trap

Figure 30A.

Rat Trap

Essential parts of the Woodbase Snap Trap

Figure 30B.



The trigger of the Woodbase Snap Trap may be expanded with cardboard or screen wire for the purpose of providing a greater surface for rats and mice to step on. This added method is adapted for use without bats as the extended trigger surface

will aid in catching the animals as they crawl over it.

See figure 31

Figure 31.

Where To Set Woodbase Snap Traps

Rats and mice rely on concealment for protection and avoid open spaces as much as possible. They will follow the contour of a room, building or fence from one location to another. The best place to set traps, therefore, is close to walls, buildings or fences. Traps should be set in such a manner that a rat or mouse that is following its natural course will pass directly over the trigger. See figure 32.

Trap setting example

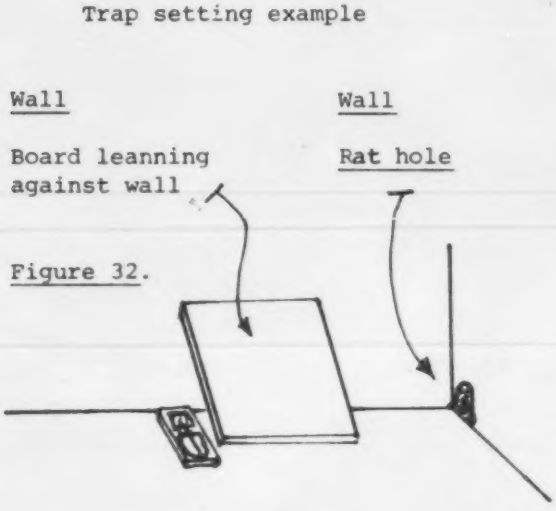


Figure 32.

In setting traps along the wall, building or fence, the traps should extend from the walls at right angles. The trigger end close against it. Boards may be leaned lengthwise against the walls, building or fence to provide cover along the runway.

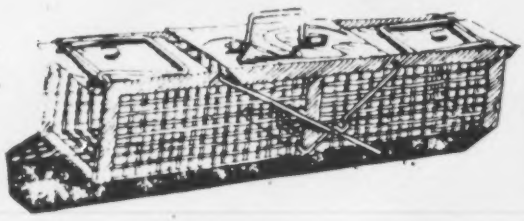
Baiting Traps

The selection of bait to be used on the trigger of the traps is very important. Baits such as meats, vegetables and cereals will usually give good results. However, the best bait to place on traps, for the most part, is peanut butter. It is advantageous to use this bait because peanut butter does not spoil or becomes rancide easily, it has an attractive aroma and its sticky consistency makes it difficult for the rats or mice to steal it without being caught.

Cage Traps

Cage traps are usually constructed from mesh wire and sheet metal and are rectangular in shape. They are less convenient and not as efficient as steel traps, but they catch rodents uninjured. Placing cage traps in areas where rodents are accustomed to feed is the proper method to apply and consideration should be given to using the same type of baits as on the Woodbase Snap Traps. See Figure 33.

Figure 33.



Steel Traps

The Steel Traps can be used as rat killing traps by placing bait on the trigger or as unbaited capturing trap. See figure 34.

Figure 34. Steel Trap

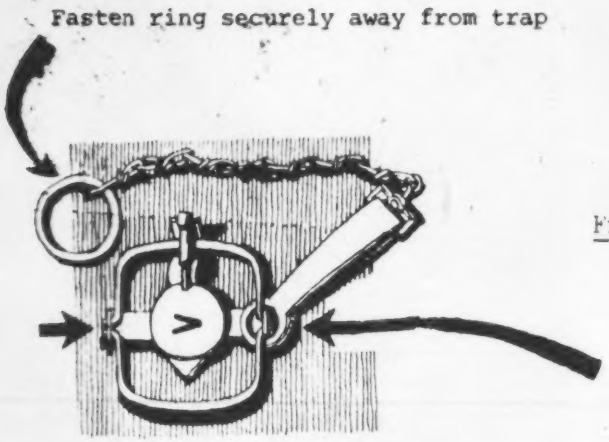


Figure 34.

General Trapping Instructions

An abundance of accessible food supply for rats and mice makes trapping more difficult. Before starting a trapping campaign be sure that there is no food within reach.

Plenty of traps should be used. A dozen or more for a private dwelling and from 50 to 100 or more for a larger building. It is important that a sufficient number of traps be used to make the trapping campaign short and decisive.

Traps should be kept in good working condition and carefully examined before setting them up in order to insure instant operation.

All traps that have set must be inspected daily. Captured rodents must be removed and the traps reset or replaced. Never set traps and leave them over the Week End or for longer periods of time.

Repellents

Rats appear to have a marked aversion to certain odors and seem to consistently avoid them. This condition allows some odors to be applied as rat deterrents or repellents and have been found useful under certain conditions.

The U. S. Fish and Wildlife Service has conducted considerable research on rodent repellents in recent years. Several of the compounds tested show promise including tetrachlor-ethyl furoate (Cefro); a compound composed of trinitrobenzene and aniline (TNBA); and a compound composed from a fatty amine and boron chloride. They have been applied in various forms such as paints, sprays or dusts to specific areas and as a coating to packaging materials.

Most repellents tested to date dissipate rapidly, so their use is practically limited to small confined spaces or selected surfaces and the applications must be repeated frequently.

Poisons and Their Mode of Action

Many people believe that the best way to get rid of rats is to poison them, but those who try to get rid of them by using only poisons alone find it a never ending job.

There are many rat poisons on the market. Unfortunately, most of them will kill any other kind of animal that eats them.

A word of caution, never expose baits where children can get to them or where animals such as dogs, cats, etc. will easily find them. Thus, a strict method of application must be followed. Never put poison on sides of buildings, in open trays or piled over a rat burrow without covering it completely. Successful rodent kills depend chiefly on the kind of bait and the method of distribution rather than the kind of poison. The best poison incorrectly applied, will give poorer results than a weak poison, correctly applied.

Antu (alpha-naphthylthiourea)

This poison when properly used is an effective quick-acting poison for the Norway rat. It causes an over production of fluid in the lungs of the rat. The animal dies of drowning, usually within 48 hours. However, this poison is not effective in the control of Roof rats or mice. Rats are strongly reluctant in accepting repeated doses of Antu, and they develop a marked tolerance for it. For this reason, Antu should not be used against the same rat population more than once a year. Antu has a good safety record as far as humans are concerned, but dogs and cats are readily poisoned by it, therefore, great care must be exercised in the placement of baits.

Zinc Phosphide

The strong pungent and offensive odor of zinc phosphide, as well as, the unattractive color, serves as a safety factor for it. However, these characteristics peculiar to this poison seemed not to affect the Norway Rat, Roof Rat or House Mouse as they take the poison very well. The poison causes heart paralysis and gastro-intestinal and liver damage. Most well-fed domestic animals will not touch baits that have been prepared with zinc phosphide, however, it is a hazard and great care must be practiced in the baits containing this poison.

Sodium Fluoroacetate, (1080)

This substance is very poisonous and very fast acting, producing symptoms in rats in 20 minutes or less after ingestion and killing the animals within one to eight hours. This is an extremely dangerous

poison to use and consequently, it is restricted to use by bonded Certified Professional Operators. Rats that have been poisoned with it get convulsions as it acts on the nervous system and death occurs from heart failure usually.

Red Squill

This poison has a bitter taste and contains a natural emetic which are characteristics that allow for a less hazardous use as a rodenticide. Rodents, unlike humans and most domestic animals, are unable to vomit and therefore are not protected by the emetic qualities of Red Squill. Red Squill kills rodents by causing heart paralysis. This single dose poison is not well accepted by the Roof rat or House mouse, but is very effective against the Norway rat. Better results are obtained if Norway rat populations are exposed to Red Squill in an attractive bait at the start of a rat killing campaign. However, because of the bitter taste of Red Squill and because the rats seem to associate the sickness with Red Squill, they may soon acquire "bait shyness". They may retain this "bait shyness" against Red Squill for about three months, therefore, it is not recommended to use the poison again within a three-month period.

Anticoagulant Rodenticides

Other types of rodenticides that are used very effectively are the anticoagulants such as Warfarin, Rozal, Pival, Prolin, Fumarin and diphacinone, are radically different in their method of killing rodents as opposed to the older acute (single dose) poisons. These anticoagulants must be ingested for several consecutive days before they take effect. This action of the

anticoagulants serves as a safety factor for a child or animal that may accidentally eat it one time.

The anticoagulant poisons cause internal hemorrhages. The poisoned rodents simply "bleed to death". The rats and mice apparently do not associate their sickness or death with the anticoagulants. Those rats that eat the poison will return again and again to eat the poisoned bait even after they become ill and weak. The problem of "bait shyness" commonly associated with the "one shot" poisons is mostly non-existent. Another factor to take in consideration in the selection of rodent poisons is that non-fatal doses of acute "single dose" poisons are often very painful, while the anticoagulants apparently cause no pain.

Suggested Formulations

Anticoagulant Baits

There are two major groups of anticoagulant rodenticides. The classification of these two groups is based on their chemical structure. The Hydroxycoumarins constitute one group and include Warfarin, Fumarin, Prolin and their water-soluble forms. The second group is referred to as the Indandiones and include Pival, Diphacin, Pivalyn, Pivacin, Promar, Rozal and their water-soluble forms.

In formulating anticoagulant baits, yellow corn meal is the bait of choice. Whole coarse-ground meal is preferable. Corn meal should be used in preference to all other baits because it has proven to be the most readily accepted, cheap bait material. If success is not obtained after using corn meal, rolled oats may be used together with the corn meal to increase acceptance. Oats are served as an

antioxidant which will prolong the shelf-life of a bait. It is not a good idea to use old, insect-infested, moldy grain or a grain that has a high moisture content. Bait acceptance problems may occur when other food is readily available to rodents or when such foods have more of an attractive odor than the poisoned food bait.

The manufacturers continue to recommend the concentration of 0.025 percent (0.250 mg. of anticoagulant per gram of bait), or a formulation in which you have one part of concentrate to nineteen parts of bait. And this is recommended for the control of domestic rats and mice.

Because mice tend to nibble here and there, it is recommended that relatively higher dosages of the anticoagulant be used such as one part of the concentrate to nine parts of bait or corn meal (0.5% concentrate when using Warfarin, Pival or Fumarin, but 0.1% of concentrate when using Rozal or Diphacin).

Anti coagulants are available as water-soluble baits which should be mixed according to lable instructions.

Dilution Factors

500 ppm (0.05%) = 1 part of 0.5% concentrate to 9 parts of bait.

250 ppm (0.025%) = 1 part of 0.5% conc. to 19 parts of bait.

100 ppm (0.01%) = part of 0.5% conc. to 49 parts of bait.

50 ppm (0.005%) = 1 part of 0.5% conc. to 99 parts of bait.

The above dilution factors apply to the following anticoagulants using at ratios of 1:19 for rat bait mixtures and 1:9 for mouse bait mixtures.

Warfarin		Rozal	0.1% Concentrate
Fumarin	0.5% Concentrate	Diphacin	0.005% finished bait
Prolin	0.025 finished bait		
Pival			

Anticoagulant Formulas

Warfarin

95 pounds Corn meal or a combination of 7 parts corn meal and 5 parts oats

5 pounds 0.5% Warfarin concentrate

100 pounds 0.025% finished bait

Fumarin

95 pounds Corn meal, same as Warfarin above

5 pounds 0.5% Fumarin concentrate

100 pounds 0.025% finished bait

Prolin

95 pounds Corn meal or the same as Warfarin above

5 pounds 0.5% Prolin concentrate

100 pounds 0.025% finished bait

Rozal

95 pounds Corn meal, or same as Warfarin above

5 pounds 0.1% Rozal concentrate

100 pounds 0.005% finished bait

Diphacin

95 pounds Corn meal, or same as Warfarin above

5 pounds 0.1 Diphacin concentrate

100 pounds 0.005% finished bait

Single Dose Poisons

Quick poisoning results may be obtained by using single dose or acute poisons such as zinc phosphide, Red Squill, strychnine-treated bait, thallium sulphate and sodium fluoracetate (1080) and these poisons should be applied only by trained, certified personnel (Certified Pest Control Operators) or personnel under their direct supervision.

Zinc Phosphide

1 pound Zinc Phosphide

0.5 pound Tartar Emetic

97.5 pounds Peanut Hearts

100.0 pounds finished bait

Red Squill

55 pounds Corn
34 pounds Oats
1 pound Peanut Oil
10 pounds Red Squill

Thallium Sulphate

30 pounds Corn
1.5 pounds Tartar Emetic
3.5 pounds Thallium Sulphate

35 pounds finished bait

Sodium Fluoroacetate

1 gallon of water
5 oz. Sodium Fluoroacetate

133 ounces of finished bait

Paraffin Formulations

When there is a need to poison rats in sewers and other humid and damp areas, [illegible]ted paraffi[illegible] used to coat anti coagulant or single dose poison baits. Wh[illegible]n this [illegible]dded material solidifies, it sheds water, resists mildew and insect infestations, and may keep baits fresh for several weeks.

In formulating these baits you may add up to 1 1/2 pounds (max.) of melted paraffin to 2 and 3/4 pounds of a grain and poison mixture in a container suitable as a mold. Discarded milk cartons which can be torn away after the mixture has set make good containers. Before the mixture has set it is advisable to introduce the end of an

8" long wire right into the bait and make a loop at the other end. The loop at the exposed end may be used to attach more wire or plastic cord, etc. in order to lower the bait block into sewers and to secure it in place.

Paraffin bait blocks in dry locations may not be accepted by rodents as those made of conventional bait mixtures. However, reports indicate good results with the use of rodenticidal paraffin bait where mixtures cannot be employed.

Some grains and some rodenticides such as oats and Pival, respectively will inhibit the formation of mildew on baits. Other preservatives such as 0.025% Dupont DDPD and 0.1% 2,4, 5 trichiorophenylacetate have been added to baits in order to extend the over period of acceptibility, but these substances may also reduce the taste acceptability to rodents.

Preparation of Baits

Fresh baits are the most acceptable to rodents. It is always best to mix just enough baits for current needs. A binder as molasses, vegetable oil, mineral oil or fish oil is often used to hold the mixtures of poisons and dry bait together and also to aid in the mixing process.

An emetic, usually tartar emetic, is mixed with zinc phosphide, thallium sulphate, antu and other single doses acute poisoned baits in order to protect humans and animals even though there acceptability is reduced. Emetics will produce vomit in humans and animals but not rats which are unable to vomit.

Baits should be mixed as directed to obtain better results.

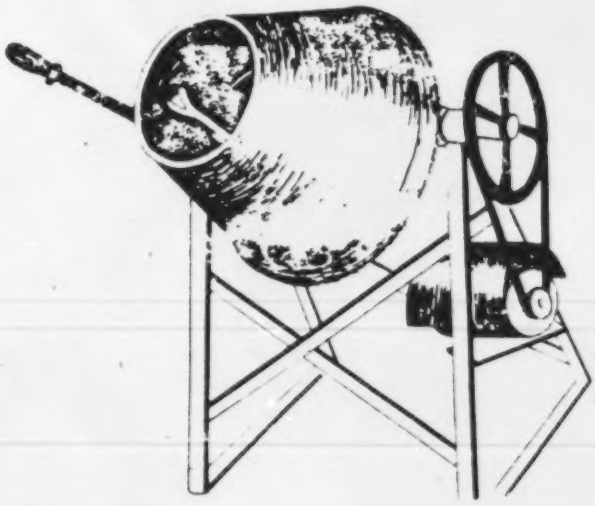
If too much poison is used, it will affect the taste and odor of the baits and their acceptability may be lowered. Too little poison will not kill and may result in "bait shyness". Excessive amounts of poison in baits increases the danger to man and domestic animals.

Mix baits well; poor mixing results in non-uniform baits, poor kills and in a speedier development of "bait shyness". Mechanical bait mixing equipment is necessary when large quantities of bait are mixed on a routine basis.

All poisons and mixing equipment should be properly labeled. Do not use mixing equipment for any other purpose. All poisons and equipment should be kept under lock and key when not in use.

Treat all poisons with respect. Avoid inhaling or getting powders or poisons on hands. Use protective equipment at all times. Always mix poisons in a well lighted and ventilated place. Below on Figure 35.

Figure 35.



Bait Placement

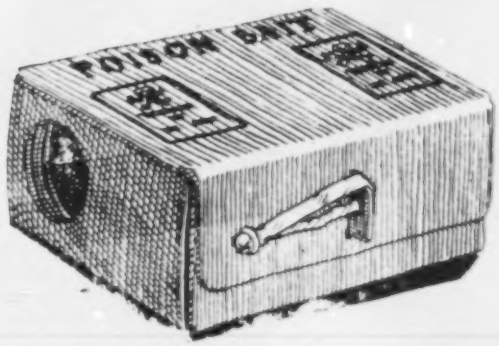
Anticoagulants are not "one shot" poisons. They require a different method of use to those other rodenticides. Bait mixtures are frequently placed in bait stations. The amount of bait to be placed in the bait stations and the number of bait stations depends on the degree of infestation of the area to be treated.

Use adequate amounts of bait in treating an area, never be short. Anticoagulant baits are usually available for a period of two weeks, but where re-infestation is likely, bait stations may be maintained on permanent basis.

Repeated dosages must be consumed by rodents in a period of five or more consecutive days in order to affect a kill, and therefore:

1. Protect other animals and humans by shielding baits in bait boxes and this also protects the bait from the weather. See Figure 36.

Figure 36.



2. Record the location of all bait containers.
3. Smooth the bait at each of the bait stations so that signs of feeding can be noted.
4. All wet, moldy or insect- ested bait should be replaced with fresh bait.

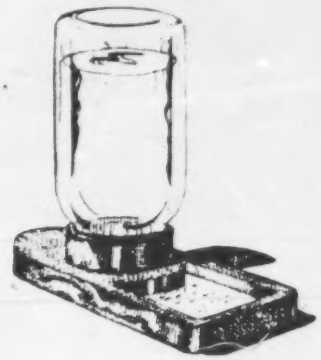
5. If at the end of successive inspections the bait remains undisturbed and there are no signs of rodent activity, you may say that the baiting campaign was successful.
6. Clearly label poisons and mixing equipment. Do not use bait-mixing equipment for any other purpose. Lock up poisons and mixing equipment when not in use.

Poisoned Water

Whenever poison water is used in the control of rodents, this water should be placed where it is not available to children or to domestic animals. Use containers that will not spill such as, glass, cups or low metal leak-proof containers. Chicken fountains are very satisfactory for permanent stations. Water baits are more effective when other sources of water are limited or can be eliminated, as in feed mills or granaries. See Figure 37.

The use of anticoagulant dust concentrate placed in a patch around anticoagulant poisoned water stations is effective in mouse control.

Figure 37.



Prebaiting

When single dose poisons are to be used, prebaiting for several

days with different kinds of unpoisoned baits may increase the subsequent acceptance of poisoned baits and bring down to a minimum "bait shyness". However, it may be too costly for a large scale baiting program. Different color of wrappers for each of the different types of baits should be used. In this manner, it is possible to find if there is any preference of bait. Pre-baiting with different color wrappers for the different unpoisoned torpedo baits, for example, the use of three baits (unpoisoned) meat, fish or grain will show which is preferred, how much is needed and where to place it.

Single Dose Poison

Single dose food baits may be wrapped in 4" X 4" paper squares to form "torpedoes" about the size of a large olive. One pound of bait will make approximately 80 to 90 torpedoes. These torpedoes may be tossed into otherwise inaccessible places. Rats prefer to carry their food to their food station or their place of harborage where they can eat it in safety. See Figure 38.

If several types of baits are used in making the torpedoes, it is advisable to use different color of wrapper for each type.

Figure 38.

Be generous in the use of baits. Rodents have a limited "home range" and this is usually less than 150 feet for rats and about

30 feet for mice. Too few baits or poorly placed baits may miss many rodents. Baits must be used liberally where signs of rat activity are numerous and recent. In light or moderate infestations, torpedoes containing a single dose poison, such as Red Squill, have given good control when applied at a minimum rate of 20 baits per private residence and 40 baits per small business establishment. As many as 100 to 200 baits may be required for premises with heavy infestations. Place baits in hidden sites out of reach of children and pets. Inspect and rebait as needed. Use another poison and bait material if the rats have become shy of the original type of bait.

"Throw Bags", which are baits or paper, moisture-resistant paper, or plastic, each containing about 1/4 pound of anticoagulant or single dose poison bait mixture, can be thrown into heavily infested sewers and into burrows and other inaccessible areas. Some operators pierce the bags in various places to make the contents more accessible to rats. See Figures 39-A and 40-B.

Figure 39-A.

Figure 40-B.

Poisoning at Dumps

Open dumps that continuously have a food supply replenished and offer harborage for rodents is a special problem in the control of rodents. Until sanitary disposal of refus is instituted, poisoning may be the only effective means of controlling rats at these sites.

Fifty to a hundred pounds or even more of poisoned bait may be required for a single heavily infested dump. Good results have been obtained by using the following techniques:

1. Wait about a day after the last load of refuse is deposited at the dump.
2. Using single-dose poison, bait heavily for several nights. If rodent ectoparasites or cockroaches are a problem, power dust with a recommended insecticide.
3. After the last day of single dose poisoning use anticoagulant bait stations and service them until all signs of feeding are terminated.
4. The area treated should be leveled and covered with two feet of dirt and in case the dump is very large than the procedure should be done a section at a time.

Poisoning in Sewers

In sewer systems, as in open dumps, rodents find a harborage and a continuous for supply and it also serves as constant source of infestation of nearby neighborhoods. Until these sewer systems are renovated or properly constructed poisoning is the only effective method of control. However, this control is short lived and a periodic method of checking and baiting must be employed in order to keep up with the problem. It has been suggested by field trials that two to

four treatments per year may be necessary to control rodents in sewers effectively.

The most effective formulation for use in humid sewers is the paraffin-poison bait mixture mentioned earlier, using either the anticoagulant or the single dose rodenticides. A wire or plastic cord to attach the block to a runner on the sewer ladder will prevent the bait from being swept away by the sewer current and it will make it possible to hang the bait block just above the water level where it will be kept drier and where it can be reached by the rats as they travel up and down the sewer ledge. This wire will facilitate the inspection of the bait blocks.

Sewers can be reservoirs of poisonous gases such as methane and carbon dioxide so it is important workers do not work alone and must be properly attired. There should be some helpers present on the surface.

Gassing

A supplementary measure for killing rodents is the use of gas in their respective burrows. Only trained, experienced and certified pest control operators or personnel under their direct supervision should attempt to carry such activity. Several poisons may be used for gassing burrows, one of them is Calcium Cyanide "A Dust" and it is very effective when it is blown into a burrow system where the rats may be found. However, calcium cyanide is not very effective when the ground is very dry. Some moisture is needed to convert the powder into a gas.

A foot pump is an ideal method with which to blow the calcium cyanide dust into the burrow. See Figure 41.

After the pump hose has been inserted a good distance into the rat burrow, the pump operator turns on the pump valve to "dust" and pumps two to six strokes with the handled provided and this in turn blows the dust into the hole or burrow system. Care must be taken that the soil is packed well around the hose to prevent any leakage into the air. After the strokes have been made with the pump valve turned to "dust", now turn the pump valve to "air" and give an additional ten or more strokes. This forces the dust through the burrow system.

Figure 41.

The operator must watch the ground nearby for the presence of escaping gas through openings not found before. These new openings must be sealed off quickly to prevent the escape of gas or rodents. Burrows may be opened after the gassing and this would mean that the gassing operation was a failure or that a new colony of rats is present, therefore, a further treatment is necessary.

Caution! ! Cyanide fumes are highly toxic and rapidly fatal. Avoid the inhalation of dust or fumes. Burrows that may lead into occupied buildings must not be gassed in order to prevent any accidents. Indoor fumigation using this type of gas must be carried out only by professional exterminators that are Certified or by personnel under the direct supervision of said professionals.

Fumigation

Fumigation is an excellent method for exterminating rats quickly in a sealed-off building, the holes of ships, boxcars or other sealed-off space. However, it is extremely dangerous work and it must be carried out by professional exterminators who are certified or by personnel under their direct supervision. All instructions must be followed. Treatment of entire buildings is not attempted on a routine basis because of the effort needed to seal-off the building and because of the dangers involved. The fumigants most commonly used are: hydrocyanic acid, gas, methyl bromide, sulphur dioxide and carbon monoxide.

Other Killing Methods

Carbon monoxide from an automobile may be used to gas rat burrows. The fumes from the auto's tailpipe are piped through a hose into the rat burrow system. All burrow entrances should be located and sealed-off prior to the operation, which prevents the rats from escaping and the gas from being diluted. All the automobile doors should be left open in case some of the gas is forced back through the exhaust system of the car. It is also advisable not to be in the car while the operation takes place.

Flooding the burrows with water may be another productive technique to employ where there are tight clay soils. Water under pressure from a garden hose andintroduced into the burrow may drown the rats or drive them out where they can be clubbed to death.

Related Problems

It is vital to control the ectoparasites of rodents such as fleas, lice, mites and ticks in order to prevent the spread of diseases to man. Since ectoparasites feed on the blood of the rodents and may get infected if the animals are diseased. When rodents are killed through trapping or poisoning, the ectoparasites are forced to find another host such as a human being. If the ectoparasites were living in a diseased animal that had a communicable disease, then it would be possible to infect humans.

It is important therefore to know ahead of time whether the rodents have a communicable disease but since this may not be

possible, it would be a good practice to use precautionary methods as controlling the ectoparasites prior to rodent control.

To treat a building or area for the control of ectoparasites:

1. Inspect the area to be treated for the presence of rat signs such as rub marks on walls or runways and burrows.
2. You may treat all runways, burrow entrances and nests with 2% Diazinon or 2% Malathion dust. Scoops, dust guns or hand shakers may be used to apply the dust to the vertical surface that the rodents will rub against when traveling back and forth.

   When the rats come in contact with the dust they carry it back to their nests on their feet and fur. This will give ectoparasite control in areas that are not normally reached.

   In the control of plague or murine typhus, the modern method to use is to dust with 2% Diazinon, 5% Malathion, 10% Carbaryl dusts in order to kill the infected ectoparasites and specifically the oriental rat flea. The dusting operation should begin at the locations where plague or murine typhus have occurred or are suspected of having occurred. Treatment should also extend to adjoining areas as needed.

Dead Rat Odors

All dead rodents should be removed as quickly as possible to remove the very unpleasant odors. However, sometimes these animals die in inaccessible areas, and the following measures may give partial are complete relief from those offensive odors:

1. The use of fans will increase the air circulation and thus cause the body fluids of the rodent to dissipate more rapidly.
2. These unpleasant odors may be masked by such products as isobornyl acetate, neutroleum alpha and bactine. These products can be used as mists sprays, as an aerosol or in a bowl with a cotton wick.
3. Oil of pine, oil of peppermint, oil of wintergreen, formalin, or activated charcoal can also be used as masking agents or deodorants. For example, ten drops of pine oil in a gallon of water can be applied with an atomizer or with a finemist sprayer.

Carcass Disposal

All carcasses of rodents that have been destroyed by trapping, poisoning or gassing operations should be disposed of in a manner that may be recommended by the Environmental Protection Agency. The unused, uneaten poison baits should also be picked-up and disposed of in the manner that is recommended by EPA. Those persons handling the dead animals should wear protective equipment.

Ratproofing

All entrances to buildings that allows the infiltration of rodents must be sealed-off. Openings as small as 1/2 inch square may allow young rats to come in. In the case where only the Norway rats are present, all openings such as ground floor windows, sidewark gratings, and foundation walls are normally rat-proofed, but when the roof rats are also found then you must cover vertical pipes, wires, openings on upper floors and roofs.

Devices Used in Rat-proofing

1. The cuff and channel for wooden doors prevent the rats from gnawing their way in. See Figure 42.

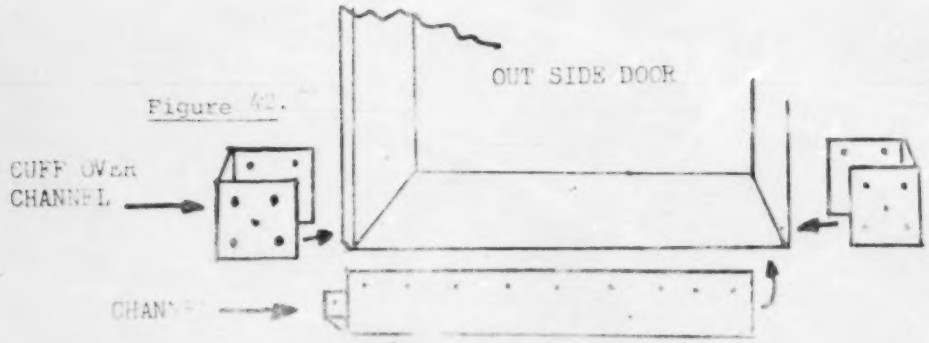


Figure 42.

2. Heavy wire mesh may be used to screen vents and windows preferable in a sheet metal frame.
3. Metal guards of suitable construction should be placed around or over wires and pipes to prevent rats from using them to gain entrance into the building.
4. Openings around pipes or conduits must be covered

with sheet metal patches or filled with concrete or brick and motar. See Figures 43-A and 44-B.

Figure 43-A.

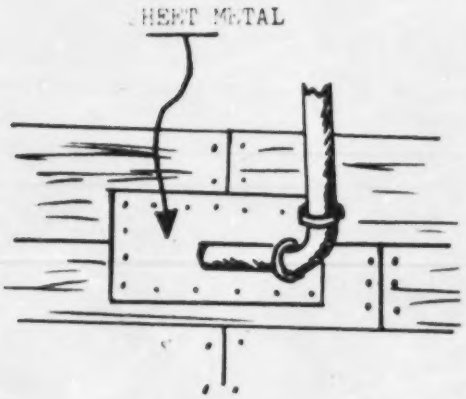
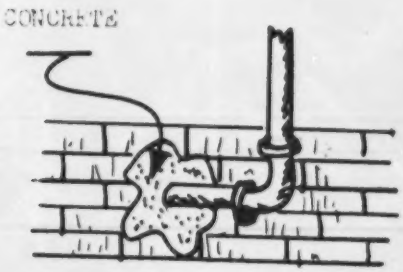
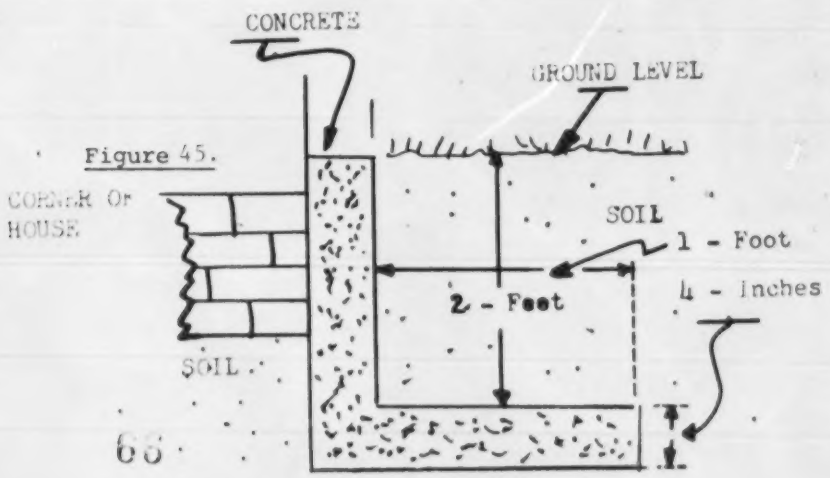


Figure 44-B.



5. L-shaped curtain walls that are made of concrete can be used where conditions allow the entry of rats through or under foundations. See Figure 45. This method is very effective in controlling the rat entering, but is very expensive. An even better method is the pouring of a concrete floor since it not only makes the building's floor rat-proofed, but it also increases the value of the property.

Figure 45.



6. Floor drains, transoms, letter drops and fan openings must not allow the rats to enter the building.

Information and Education

One of the major elements in rodent control is a strong educational program in environmental sanitation.

Community-wide control of rats is largely a matter of a coordinated and simultaneous efforts of applying available information and common sense to a universal problem using, some rather specialized techniques.

Many people endure the presence of rats rather than exert any effort on their part to get rid of them; needless to say that the creatures will perish or vanish if food, water, and shelter are denied them with sufficient success to interfere with their abundant life. The problem can be controlled if citizens have courage enough to develop a spirit of neighborliness, for neighborhood pride develops into civic pride and produces national pride.

In order for a rodent control program to be successful, educational and promotional activities must reach the neighborhood. This is accomplished by the transmission of information through the uses of personal contact, pamphlets, films, mass media (radio, television, newspapers) etc.

Edcuation is essential for the growth of block clubs and community organizations which are the contributors to the citizens participation phase of the program.

The essentials of rodent control should be taught in the schools to all students of a receptive age group.

It takes time and much dedicated effort to obtain constructive and positive participation, therefore, meetings and clean up campaigns should be held periodically to give and maintain enthusiasm and support.

The effectiveness of a rodent control program will be transitory and limited if the killing of rats is the primary goal. Education of urban residents on community sanitation is a way to reach beyond the short term successes of rat poisioning activities. Education in this instance is for the purpose of improving the knowledge, attitudes and behavior of residents about environmental sanitation and for improving the livability of the environment.

SUMMARY

The purpose of the training manual is to give a better understanding of the rodents to be controlled, their habits, their biological characteristics, their physical characteristics, their environmental requirements and the various methods used to control them.

Rodents are filthy and destructive as has been demonstrated in this manual and they play a part in the spread of diseases, as well as, in economic losses.

Rodent killing may be accomplished in many different ways depending on the existing conditions and circumstances. However, whatever methods are used the results may be only temporary.

In order to obtain lasting control of rats and mice, all possible methods must be exercised and a constant vigilance must be maintained in order to detect the first signs of infestation. Of course, the most effective method for the control of rodents is the elimination of all available food in the environment.

This is easier said than done, since a lot of materials are used as food by rodents and there is always a certain amount of water to be found. Even if all refuse was properly stored and disposed, still, there are vegetable gardens and fruit trees that would provide food for rodents. However, if all sources of food are eliminated from our cities, then the rats and mice would simply have to move out into the wilds again where they would be dependent on environmental factors for their existence. This isn't going to happen, so we have to deal with the problem of controlling rats in our city.

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